SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

DRAFT STATUS REPORT ON RULE 1113 – ARCHITECTURAL COATINGS

Dated: June 2005

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Purpose of this Report

This report serves the following purposes.

- Sixth annual progress report prepared in accordance with the 1999 Board-approved Work Plan for implementation of Rule 1113 – Architectural Coatings.
- Report on progress toward achieving compliant products with respect to the coating categories subject to the July 1, 2006 limits in the rule.
- Progress on Reactivity and Availability assessment of solvents found in architectural coatings

The South Coast Air Quality Management District (AQMD) has contracted with the University of Missouri – Rolla Coatings Institute (UMR) to conduct a laboratory study of architectural coatings, which is currently ongoing. This report incorporates results recorded to date. The remainder of the results will be incorporated in a follow up to this report to be presented in October.

Background

On August 13, 1999, the Board approved a workplan that required submittal of annual status reports summarizing issues and activities regarding the implementation of Rule 1113-Architectural Coatings. The first report, submitted on July 21, 2000 has been followed each year by new information on the implementation of future volatile organic compound (VOC) limits in the rule. In addition to rule requirements for technology assessments of specific coating categories, a Board approved resolution in December of 2002, ensured the continuance of annual reports with a focus on the progress towards achieving the 2006 VOC limits found in the rule. This is the sixth such report that staff will have presented to the Board.

As mentioned in previous annual reports to the Board, the TAC is an important committee that staff relies upon for technical expertise and valuable feedback on all aspects of architectural coatings. The TAC was first formed in February 1998 to provide technical oversight of the Phase II Assessment Study and future technology assessments, including selection of coatings, relevant testing, and the report formats. The TAC also evaluates data to identify links between performance characteristics and the emission potential of architectural coatings. The current makeup of the TAC includes representatives of several large and small manufacturing companies, the CARB, the National Paint and Coatings Association, a consulting and engineering firm, a painting contractor and several members from academia.

AQMD staff believes that the significance of emissions contributing to ozone formation in the South Coast Air Basin (Basin) from volatile organic compounds (VOCs) attributable to architectural coatings continues to be a critical component for attainment of Federal and State standards. The latest California Air Resources Board (CARB) architectural coating survey for 2000 sales, show more than 50 tons per day of VOCs are attributed to the application of architectural coatings in the Basin based on demographics. After implementation of Rule 1113 lower VOC limits effective in 2001 and 2003, the 2003 Air Quality Management Plan (AQMP) estimates the remaining architectural coating VOC inventory at 38.36 tons per day in 2005.

Annual Progress Report

The intent of this annual report is to provide the latest information on the availability and performance of architectural coatings subject to current and future compliance limits. The results of surveys, data searches, laboratory testing and evaluation of coatings, in-situ coating performance and available compliance options built into the rule are some of the topics covered in this report. The information contained in this report includes the following:

- Technical information gleaned from technical data sheets (TDS), Material Safety Data Sheets (MSDS), technical papers, and OEM brochures that demonstrate that VOC products meeting the future VOC limits are in use and available to all consumers.
- Product surveys, compliance inspections/audits and ongoing laboratory testing continue to show an increase in the use and application of compliant and super-compliant coatings meeting the 2006 and other future VOC limits in Rule 1113 for all categories.

Future Program Activities and Studies

AQMD staff is committed to continue researching all coating categories for additional products that show compliance with current and future rule limits. As the 2006 limits approach, more coatings are becoming available in all categories and the successful, voluntary use of available technology is evidence that the coatings are performing at or above industry expectations. Discussions with the Technology Advisory Committee (TAC) continue and staff has asked them to provide a list of coatings that they would like included in potential future assessments.

As technology improves and VOCs in all categories get closer to zero, staff will continue to research the feasibility of further reductions in the VOC content of all architectural coating categories as currently listed in the Table of Standards for Rule 1113.

A follow up to this report will be presented in October of this year

Availability and Performance of Compliant Coatings

CARB Survey

Rule 1113 requires AQMD technology assessments to consider any applicable CARB surveys on architectural coatings. Approximately every four or five years since 1976, CARB has conducted architectural coating surveys. The survey methodology serves as a tool to obtain information such as VOC content and sales volume of coatings from manufacturers that offer products for sale in California. Data obtained for 2000 represents the latest information available that gives a comprehensive evaluation of sales data and coating chemistries supplied from manufacturers.

The sales data obtained for 2000 categorized architectural coatings statewide into 51 categories, identifying more than 98 million gallons of architectural coatings sold in California in 2000, with 83 percent of that volume coming from waterborne products and the remainder from solvent borne coatings. However, waterborne products contributed to only 41 percent of the total emissions, while the solvent borne products contributed to 59 percent of the total emissions. The sales of architectural coatings in the AQMD are based on an estimated population representing 45 percent of all coatings sold statewide. Table 1 below summarizes the use and contribution of waterborne and solvent-based coatings from the most recent CARB survey.

Table 1
CARB Survey - California

	Waterborne	Solvent-Based
Total Volume (%)	83	17
Total Emissions (%)	41	59
Annual Volume (Gal/Yr)	81,548,961	16,906,211

Table 2 below summarizes information extrapolated from the 2000 sales data for the CARB 2001 Architectural Coatings Survey, that lists the total number of products, sales volume, as well as number and percent of products, and percent volume of sales that currently meet the future Rule 1113 VOC limits for categories with future limits (excludes quart containers or smaller).

Table 2
CARB 2001 Survey Results

Coating Category	Total Products Listed	Total 2000 Sales Volume (gallons)	# of Products Meeting Future VOC Limits	Sales Volume meeting Future VOC Limits	% of Products Meeting Future VOC Limits	% of Sales Meeting Future VOC Limits
Floor	715	1,403,122	111	688,922	15.5%	49.1%
Industrial Maintenance	3,751	4,527,118	312	517,868	8.3%	11.4%
Nonflats	4,786	25,699,430	153	321,798	3.2%	1.3%
Primers, Sealers, & Undercoaters (PSU)	905	7,941,252	283	2,626,489	31.3%	33.1%
Quick-Dry PSU*	121	1,611,339	3	39,442	2.5%	2.4%
Rust Preventative	81	180,522	3	1,047	3.7%	0.6%
Exterior Stains	1,315	2,741,425	126	313,266	9.6%	11.4%
Varnishes	427	664,414	87	236,557	20.4%	35.6%
Water Proofing Sealers	234	1,006,632	76	256,122	32.5%	25.4%

Water Proofing Concrete/Masonry Sealers	125	700,028	61	285,206	48.8%	40.7%
Total	12,460	73,044,023	1,215	5,615,972	9.8%	7.7%

*- Subsumed into the PSU Category

When comparing the data from previous CARB surveys, this most recent sales information provided by coating manufacturers indicates an increase in the overall sales volume of lower VOC products in many categories that meet the AQMDs proposed future limits. CARB is currently compiling 2004 sales data for the CARB 2005 Architectural Coatings Survey that should be available later this year.

Using the data from the surveys every four years, CARB has calculated the associated emissions. Table 3 contains summary data from these surveys. Please note that the surveys have varied in content and format. Therefore, it is not always possible to make a direct comparison between results from different survey years.

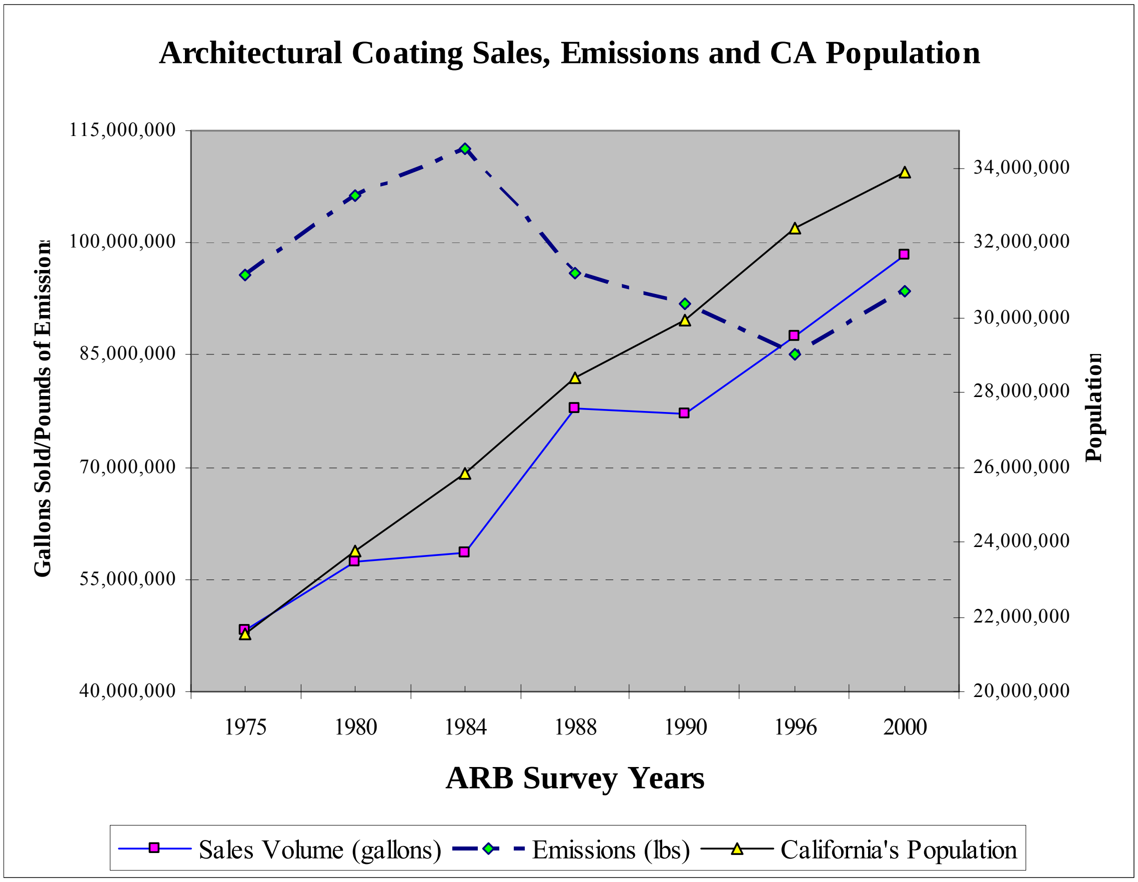
Table 3

CARB Architectural Coatings Volume and Emissions Trends

Survey Year	Sales Volume (gallons)	Emissions (lbs)	California's Population	Pounds of VOC Emissions per capita	# of Surveys Mailed Out	# of Companies Reporting Sales
1975	48,206,000	95,776,000	21,538,000	4.4	N/A	N/A
1980	57,247,000	106,211,000	23,782,000	4.5	N/A	N/A
1984	58,481,000	112,532,000	25,816,000	4.4	~400	143
1988	77,876,000	96,056,000	28,393,000	3.4	N/A	130
1990	77,056,000	91,842,000	29,944,000	3.1	N/A	174
1996	87,496,000	85,142,000	32,383,000	2.6	>700	152
2000	98,455,172	93,629,000	33,871,648	2.8	700	183

Emissions include emissions from thinning and cleanup solvents.
N/A = Not Available

Graph 1



In summary, the chart shows that while California's population and sales volume of coatings continue to grow, statewide VOC regulations requiring lower VOC limits has been able to keep the emissions from architectural coatings slightly lower than the 1975 emission levels. Regulations began having an effect on architectural coating emissions by 1984 and continued to lower the emissions until 1996. Most of the state regulatory action after 1996 should begin to show some effect on emissions after 2000. The CARB 2005 Architectural Coatings Survey will contain 2004 sales and emission data.

Specific Coating Category Assessments by AQMD Staff

The following categories have lower VOC limits, effective July 1, 2006:

- Clear Wood Finishes
- Floor Coatings
- Industrial Maintenance Coatings (IMC)
- Nonflat Coatings
- Primers, Sealers and Undercoaters (PSU)
- Quick-Dry Enamels (QDE)
- Quick-Dry Primers, Sealers, and Undercoaters (QDPSU)

- Rust Preventative Coatings
- Specialty Primers
- Waterproofing Sealers (WPS)
- Waterproofing Concrete/Masonry Sealers (WPCMS)

As the July 1, 2006 limits approach, AQMD staff continues to evaluate and review these and all other coating categories in the Table of Standards in order to further evaluate the availability of compliant products.

An analysis of TDS and MSDS published by coating manufacturers is one methodology used to complete assessments of available coatings. A summary of this assessment can be found in Appendix A of this report, containing a list of compliant coatings for each of the categories studied, ranging from zero-VOC to the current VOC limits. This list is continually updated as staff reviews additional information on compliant and super-compliant architectural coating products. The term "super-compliant" refers to architectural coatings that exceed the current and/or future limits for the applicable coating categories as set forth in the Table of Standards found in paragraph (c)(2) of Rule 1113 and are indicated by the manufacturer as having less than 10 g/l of VOC containing materials. The TAC has also contributed and reviewed this list for accuracy.

In addition to TDS and MSDS review, staff continues to visit sites where architectural coatings are applied, and has conducted follow-up visits to previously documented applications of low- and zero-VOC coatings. The data gathered is used to substantiate the availability, use and continuing performance of low-VOC coating products.

AQMD staff has visited more than sixty new construction sites in 2004 and 2005 in order to determine compliance with Rule 1113. Some of the sites visited by staff had coatings specified that either did not meet current VOC limits in the rules, or were not covered under the Averaging Compliance Option under Rule 1113. Staff was able to point out the inconsistencies and have them corrected prior to the application of the non-compliant products during the construction phase. Overall, most of the construction sites visited had applied super-compliant architectural coatings that meet the future limits in Rule 1113.

Table 4 lists a portion of the project locations visited by staff, as well as some of the coatings specified and applied at those sites.

Table 4

Construction Sites Utilizing Super-Compliant Coatings

Facility	Location	Product	Coating Category	Product VOC	Future Limit
Alliance Residential Company	Upland	Dunn-Edwards Super Wall	Flat	50 g/l	50 g/l
"	"	Dunn-Edwards Ultra Grip	PSU	45 g/l	100 g/l
Bridgeport Cove	Santa Clarita	Vista Paint 3600 Flat	Flat	49 g/l	50 g/l

Chaparral Elementary School	Chino Hills	Vista Paint 4200 Terminator II	PSU	50 g/l	100 g/l
Gateway Village	Santa Clarita	Dunn Edwards Ultra Grip Primer	PSU	45 g/l	100 g/l
The Heights	Chino Hills	Frazee Int/Ext Prime Plus	PSU	60 g/l	100 g/l
"	"	Frazee W/B Lacquer Undercoater	PSU	49 g/l	100 g/l
LA Regional Transportation Management Center	Los Angeles	Sherwin Williams Promar High Holdout Primer	PSU	82 g/l	100 g/l
Macys	Rancho Cucamonga	ICI Devflex 4020PF	Rust Prev.	91 g/l	100 g/l
"	"	ICI Prep & Prime W/B Primer	PSU	100 g/l	100 g/l
Sommerville Conzelman	Rancho Cucamonga	Dunn-Edwards W101	PSU	60 g/l	100 g/l
Hector Godinez High School	Santa Ana	MonoChem Aqua Seal ME7	WP Sealer	0 g/l	100 g/l
"	"	MonoChem Aqua Seal Silane 29	WP Sealer	65 g/l	100 g/l
"	"	MonoChem Primer Sealer	PSU	0 g/l	100 g/l
Kaiser Permanente Medical	Ontario	C&A Floorcoverings C-36E Floor Primer	Floor Coatings	0 g/l	50 g/l

The following pages summarize staff's findings relative to the specific coating categories that have to meet lower VOC limits by July 1, 2006 and each year that the annual report to the Board is presented, the list continues to grow.

Clear Wood Finishes

Rule 1113 defines clear wood finishes as products applied to wood substrates to provide a solid film. An analysis of product data sheets supplied by various manufacturers supports staff's conclusions that the future limit of 275 g/l VOC and much lower is currently achievable. Appendix A of this report shows more than 60 products that have a significantly lower VOC content than the future limit. Additionally, staff continues to visit sites where future compliant products in this category have been applied showing excellent performance, even when subjected to harsh conditions (high traffic) such as manufacturing areas.

Comments received from previous reports presented to the Board questioned the long-term durability of low-VOC coatings. Staff has re-inspected many of those sites where low-VOC products were applied, and has documented the results. One such follow-up was at Barneys of New York in Beverly Hills where BonaKemi products were applied. As mentioned in the annual report to the Board in December of 2003, BonaKemi USA manufactures and sells the BonaTech MEGA® Brand Floor Finish that has a VOC of 250 g/l. This product is specifically designed for use on interior residential and commercial wood flooring subject to heavy traffic. The resin system used in this single-component product is polyurethane. Independent testing conducted by Colorado State University and the Taber Abraser testing indicate that the "MEGA® outperforms all other competitor's waterborne and oil-modified finishes." The BonaTech MEGA® Satin

Floor Finish was applied to the fourth and fifth story wood floors at the Barneys of New York site during September of 2003. The contractor applying the less than 250 g/l VOC product stated that he uses the clear coating on most of the commercial and residential jobs he does and says he is a "big fan" of the product and that it is very durable. He estimated that Barneys of New York would not need a maintenance coat for approximately five years. Staff returned to the site nearly a year after the coating was applied and spoke with the Director of Store Operations. The Director stated that the coatings were holding up well and that no touch-ups had been required. While staff was present, the third floor was under restoration by a different contractor utilizing the same products.

IMC

The IMC category continues to be part of every study conducted by the AQMD. Various public service agencies have completed testing of low-VOC products in recent years and has found compliant products with acceptable performance. Metropolitan Water District (MWD) continues to test new products that meet their internal standards for performance and that also meet the future VOC limit of 100 g/l. Staff expects to obtain information from MWD over the next few months.

The overall results of the completed studies indicate that coatings meeting the future limit of 100 g/l are currently available for the industrial maintenance coating category. Staff continues to obtain additional information from TDS and MSDS analysis. Appendix A includes over 140 Industrial Maintenance Coatings *(more than twice the number reported in the 2003 annual report to the Board)* that are well below the July 1, 2006 100 g/l VOC limit. AQMD staff continues to work with the agencies in the evaluation of IMCs through additional testing and evaluation of various manufacturers' products for use in severe environmental conditions. Staff expects to present a summary of these findings in the October report to the Board.

Nonflat Coatings

Rule 1113 – Architectural Coatings defines nonflat coatings as registering a gloss of 5 or greater on a 60 degree meter and a gloss of 15 or greater on an 85 degree meter. The rule does not delineate various gloss ranges into distinct categories such as high, medium or low gloss.

There have been comments received from some manufacturers that a high gloss category should be developed in Rule 1113, similar to the 2000 CARB State Suggested Control Measure (SCM) for Architectural Coatings. In the SCM, high gloss coatings are those that register a gloss of 70 or above on a 60-degree meter and are allowed a higher VOC limit of 250 grams per liter. Some manufacturers have stated that acceptable coating performance characteristics for high gloss low-VOC coatings are not available. However, Appendix A lists high gloss coatings that are currently available and are below the 50 g/l limit that will be in effect in July 2006.

The list of currently available ultra-compliant nonflats also continues to grow, as indicated by staff reviews and updates of information based on TDS and MSDS. There are currently over 70 coatings below 50 g/l listed in Appendix B. This is more than double the number of coatings listed in the report to the Board in December of 2003, indicating an increasing number of available future compliant products. AQMD staff and millions of others in the Do-It-Yourself (DIY) market purchase these future compliant products for their personal use in and around their homes.

Despite the increase in the availability of coatings in this category below 50 g/l, the rule incorporates alternative compliance options, such as the averaging provision. AQMD staff is committed to further research in this area and remains open to further discussions on the issue with the TAC, and the possibility of conducting additional testing for nonflat high gloss coatings.

PSU/QDPSU

An analysis of currently available PSUs clearly shows that the future VOC limit of 100 g/l VOC by July 1, 2006 is attainable today. More than 100 coatings have been identified, through TDS, MSDS and on site inspections that are well below 100 g/l VOC. Previously, Table 4 listed construction sites that were randomly visited by staff throughout the AQMD jurisdiction, where PSUs were applied that meet the future limits. Those coatings are applicable to a wide variety of substrates and provide physical coating characteristics that meet or exceed the performance standards typically expected of products from industry and consumers. Although not specifically called a quick dry product, many standard PSUs meet the definition of a quick dry coating and consequently are included in the staffs' analysis as a primer, sealer or undercoater.

QDE

A subcategory of nonflats, QDEs have gloss values greater than 70 on a 60º meter and should be capable of achieving set-to-touch in at least two hours, dry-hard in at least eight hours and be tack-free in at least four hours. There are coatings listed in Appendix A of this report under the nonflat category that meet this definition.

Rust Preventative Coatings

CARB surveys continue to show an increase in the number of rust preventative coatings for sale at VOC levels that meet the future limit of 100 g/l. AQMD staff evaluation indicates that super-compliant coatings with zero-VOC are currently available. These are single component, direct-to-metal (DTM) coatings that provide corrosion resistance for interior and exterior metal surfaces. Appendix A lists 15 DTM rust preventative coatings that meet the future VOC limit and are currently available from various manufacturers. Additionally, numerous products labeled as nonflats, and not specifically rust-preventative coatings, have anti-corrosive characteristics that make them suitable for application and use for the prevention of rust on metal surfaces, as indicated in manufacturer product literature. An example of a zero-VOC rust preventative coating is a product made by Sierra Performance (Rust-Oleum) called Metalmax™ DTM Acrylic Urethane Enamel, listed on Page 30 of Appendix A.

During a random field visit to a Macy's Department Store construction site in Rancho Cugamonga, AQMD staff encountered the specification and application of a rust preventative coating manufactured by ICI Devoe. The coating is called ICI Devflex 4020PF and contains 91 g/l VOC.

Specialty Primers

Specialty primers are defined in Rule 1113 as coatings intended to seal fire, smoke or water damage, or to condition excessively chalky surfaces. Many of the coatings that fall within other categories, such as PSUs, have characteristics similar to requirements for specialty primers, such as the need to condition excessively chalky surfaces. A review of the available products listed under PSUs and the associated characteristics in Appendix A indicates a vast amount of coatings available that meet those needs. As mentioned in the report to the Board in December 2003, sales data supplied by manufacturers and available for review in the 2001 CARB Survey, indicate that approximately 80% of the total market volume within this category is below the future limit of 100 g/l VOC, effective July 1, 2006 (including stain-blocking products).

WPS/WPCMS & Floor Coatings

Appendix A of this report lists well over 50 coatings that are less than 100 g/l VOC meeting the July 1, 2006 limits for the WPS and WPCMS categories. Also, many of those same coatings listed are utilized in vertical and horizontal floor applications with VOCs that easily meet the future limit in the floor category of 50 g/l VOC.

Store Product Shelf Inventory Submittals

AQMD staff conducted a survey of store inventories in the spring of 2004. The purpose of the survey was to gather usable data that would provide a snapshot of the currently available architectural (and adhesive-Rule 1168) products that are being sold from various store shelves. This survey also provided data on the compliance level of the store inventories. The additional benefit to this project was that many of the store owners, corporate executives, and suppliers were made aware of the AQMDs current and future VOC limits relative to Rule 1113.

As part of this expansive outreach effort, AQMD staff prepared a distribution list for the survey along with useful compliance information on Rule 1113. The list was generated from various sources, including the Yellow Pages, internet web pages, and recommendations from retail outlet personnel. An outreach letter was then drafted and mailed to 654 stores within the AQMDs jurisdiction. Staff received a total of 96 store inventory lists back from the stores. It should be noted that many of the stores had their corporate offices handle the inventory list that explains the rather large disparity between the two figures. As an example, stores such as Sears, True Value Hardware, Home Depot and ACE Hardware Supply had many individual store locations in the AQMDs jurisdiction.

Staff continues to evaluate the large amount of data that was provided. Categories such as flats, nonflats, and IMC coatings are being evaluated for current rule compliance as well as upcoming VOC limitations.

Summaries of Architectural Coating Articles on Advancements in Technologies

As AQMD staff continues to research new coating technologies that are available across all coating categories, it becomes clear that compliance has relied heavily on the research and development efforts of the raw material suppliers to the architectural coatings industry, and active follow up by individual coating company reformulations. Numerous articles, journal publications, and technical bulletins discuss progress in the area of lower VOC products for the coatings industry, primarily to meet the demand driven by regulatory concerns, as well as the desire of the general public and governmental agencies to specify and use environmentally-sound products.

The following summaries of articles are provided as testimony to the ongoing technology achievements based on those research and development efforts across a wide array of coatings manufacturers and raw materials suppliers throughout the world.

www.basf.com/businesses/consumer/dispersions/usa/archcoat/products/optive130.pdf
This article was released on October 28, 2002.

BASF Corporation's Architectural Coatings Raw Materials Business Unit has introduced Acronal Optive® 130, a technological breakthrough in exterior and interior architectural coatings in zero and low VOC formulation that delivers high performance for flat through semi-gloss paints without sacrificing critical paint performance and at a lower formulated cost. Acronal Optive 130 provides formulators and manufacturers the ability to meet existing and expected future VOC regulations today without having to reformulate today and then again in a few years. For semi-gloss paints, Acronal Optive 130 delivers a high level of block resistance, scrub resistance, gloss, and wet adhesion in zero to 150 g/l VOC formulations. In flat paints, Acronal Optive 130 exhibits excellent low temperature touch-up, high scrub resistance and superb thickener efficiency in zero to 150 g/l VOC formulations. Acronal Optive 130 is composed of an all-acrylic backbone providing excellent outdoor durability and supported by long term exposure testing. Acronal Optive 130 does not require a coalescent to form a film, giving the formulator the option of reducing formulated costs and/or adding additional glycol for increased open time. The enhanced thickener efficiency of Acronal Optive 130 and the ability to replace several polymers with one gives manufacturers an additional economic and performance advantage.

This product is currently being used in large volumes by most of the manufacturers selling architectural coatings in California. In addition, BASF offers other Acronol products such as 110, 230 and 330 polymers that can be used for coatings at 50 g/l or less.

The effect of Water Resistance on the Durability of Waterborne Coatings. David Kelly, Project Leader, Architectural and Functional Coatings Research, Rohm & Haas, Spring House, PA., October 22, 2003.

Water resistance, UV resistance and the ability to resist damage on thermal cycling are some of the main components that determine exterior durability of many types of coatings. Coatings that are used on low-slope (or flat) roofs need to have high water resistance for good durability, due to the possibility of ponds forming on these roofs as well as needing good UV resistance and resistance to thermal cycling damage. Under conditions of ponded water, coating blistering is evidence of poor water resistance.

Water borne coatings are especially susceptible to durability issues pertaining to poor water resistance. Most formulation components for waterborne coatings are either water soluble or have colloid stability (e.g., latex polymer). In all cases, the functional groups on polymers that are used are susceptible to hydrogen bonding or are ionic. Unless the hydrophilic character is balanced with the hydrophobic, the coating will either be water sensitive or the formulation will not have colloidal stability. In addition, the water sensitivity of the latex polymer binder may also impact overall coating water sensitivity. In addition, the water sensitivity of the latex polymer binder may also impact overall coating water sensitivity. We have used coating water absorption, water vapor permeability and blister resistance to characterize the factors in waterborne coating formulations that pertain to water sensitivity. The factors studied include formulation components for stability and rheology control, as well as latex polymer hydrophobicity.

Our research shows that waterborne coatings can be made resistant to water and durable to ponded water situations such as those that might be encountered on low-slope roofs. We have found that hydrophobic components in the formulations, as well as the use of hydrophobic binders, will give the best combination for improving the water resistance of waterborne coatings. This will result in waterborne coatings that can resist blistering over hydrophobic substrates for up to four to six months of continuous immersion in water. However, in the design of polymers for ultimate durability, the UV resistance of hydrophobic materials must also be considered to give the best exterior durability.

Information from Paint Square and the Pugh & Co. International web-site, January 21, 2005.

Pugh & Co. International has developed an ultra low-VOC primer, Actan® GS, with a VOC content of less than 0.1 g/l. The primer has been developed for treating galvanized and non-ferrous metals and bonds with the surface to form a film that is transparent, hard, flexible, impact resistant and non-porous. It gives great adhesion prior to the application of a wide range of one and two pack protective paint systems, including chlorinated rubbers, vinyls, acrylics, epoxies and polyurethane. This product has been certified by the British Board of Agrément under the Highways Authorities Product approval Scheme for use as part of a specification for the protection of steelwork in accordance with the Manual of Contract Documents for highway Works. The primer is currently being used with a 100 percent water based paint system to protect pipe-work in one of the tunnels beneath the Thames Barrier in London. In addition, Pugh & Co. International have also developed Kelate® which is a high quality water-borne product that neutralizes the corrosion process. It reacts quickly with the rust and transforms iron oxides into a stable and insoluble blue-black metallo-organic complex which is ready for painting after reaction. Reaction time is approximately three hours. This product is supplied to major paint manufacturers all over the world for making chelating surface treatment and is 100 percent VOC free. It is a chelating polymer that has been designed for field application to rusted steel which has been hand or power cleaned, or blasted.

<u>Chemolak, Tovarenska 1, 91904 Smolenice, Slovak Republic, Tel: 421-805-55-60-611, Information found on internet website, www.rec.org/ecolinks/bestpractices.</u>

In Slovakia there are 25,000 tons of VOC released yearly into the air and the reduction of VOC emissions is a high priority. Chemolak, a European paint manufacturer in the Slovak Republic produces approximately 20,000 tons of coatings per year. In 2000 Chemolak began a project to replace harmful organic solvents with water-based polyurethane dispersions in manufacturing paints and lacquers. With the substitution of this environmental friendly technology, emissions were reduced to 10 percent of former levels. The new process avoids the emission of 500 tons of VOC per year. The project resulted in environmental benefits as well as economic benefits such as the polyurethane product is 5 percent less expensive than other currently available similar products, a polyurethane dispersion produces quality varnish products, market potential is increased because of residential use, and the company is in compliance with new environmental legislation.

<u>Market Updates for Resin Manufacturers, JCT Coatings Tech, January and February 2005</u>

Lyondell Chemical Company commercialized its Acryflow™ line of acrylic polyols which are prepared in a proprietary process using hydroxyl-functional allylic monomers. Acryflow polyols maintain their functionality at a low molecular weight so coating formulators do not need to trade performance for lower VOC content. These Acryflow polyols are designed to be blended together for use in a variety of applications including high-solids, UV, and moisture-curable coatings. The blending approach optimizes formulation latitude while reducing resin inventory costs, increasing coating performance, and lowering VOC content.

The Rohm and Haas Company has introduced several new products for low-VOC architectural paint applications. Rhoplex™ AC-364 and Rhoplex Multilobe™ 300 are 50 g/l flat binders and they are developing and close to launching 50 g/l VOC semi-gloss and high gloss binders that will give the performance of their conventional counterparts.

The Lubrizol Corporation acquired Noveon which introduced Sancure® 20041 a low-VOC polyurethane dispersion for clear wood finishes. Noveon also launched several coatings resins for architectural and masonry/specialty construction applications. Carboset® XPD-2860 is an acrylic emulsion for zero-VOC interior and exterior latex paints that possesses outstanding scrub resistance. Carboset® 7733 is an acrylic emulsion for low-VOC interior and exterior semi-gloss and gloss paints that also offers excellent scrub resistance. Carboset® XPD-2790 is an acrylic emulsion for low-VOC primers with excellent tannin and stain blocking. Noveon will be introducing a new low-VOC, high-solids, waterborne oil-modified polyurethane for clear or pigmented interior or exterior wood coatings.

BASF is investing in future opportunities for nanotechnology-based latex resins, and has demonstrated with early prototypes that nanoparticles can impart extraordinary strength and hardness with very low-VOC demand.

Reichhold is developing Arlon® 848, which is a water-based acrylic emulsion resin that is low in VOC and low in HAPS, designed for airless spray applications possessing excellent corrosion resistance and use in direct-to-metal applications.

<u>Micro-Dispersion™ - A New Water-Borne Technology, Joseph Nothnagel, Eastman Chemical Co. Presented at the International Waterborne, High-Solids, and Powder Coatings Symposium, February 26-28, 2003.</u>

Because of government regulation of VOC over concern for the environment and public health, competing technologies have developed in the coating industry to lower the VOC content. Two distinct types of waterborne coatings continue to command the bulk of research which are emulsion polymerization in which hydrophilic assistants are used in order to ensure the stability of the dispersion and replacement of some of the solvent with water as part of the medium to carry the film-forming components of the paint. These near zero VOC Micro-dispersion coatings have extremely low acid values, no external surfactants, small particle sizes and high molecular weight (equal to or greater than conventional solvent based polymers. This abstract devotes most of the discussion to the micro-dispersions and also briefly discusses other alternative compliant technologies.

<u>Eartheasy.com</u>

Indoor air is three times more polluted than outdoor air, and according to the EPA, is considered to be one of the top 5 hazards to human health. Paints and finishes release low level toxic emissions into the air for years after application. The source of these toxins is a variety of VOCs, which, until recently, were essential to the performance of the paint. New environmental regulations, and consumer demand, have led to the development of low-VOC and zero-VOC paints and finishes. Most paint manufacturers now produce one or more non-VOC variety of paint. These new paints are durable, cost-effective and less harmful to human and environmental health.

<u>Radical Change in Research and Development, Dean C. Webster, North Dakota State University, JCT Coatings Tech, April 2005.</u>

Paint and coating formulations are a complex mixture of one or more resins and crosslinkers, solvents, curing catalysts, flow and leveling additives, gloss modifiers, stabilizers, pigments and their dispersants and dispersion stabilizers and so. Coatings are also required to meet a combination of performance requirements. Coating formulators are challenged to use whatever information they can gather to help them decide what ingredients to use and in what ratios to mix the ingredients in order to achieve the optimum in performance properties. The process of formulating new coating products has largely remained unchanged for over 100 years and statistical experimental design has not yet become standard practice for coatings formulators. Combinatorial and high throughput methods have been practiced in the field of drug discovery for over a decade. It was recognized that it was almost impossible to predict what specific chemical compound would have a desired effect in treating a disease or condition. Synthesizing a series of compounds one at a time and testing them one at a time is an extremely inefficient use of resources. Methods were developed to facilitate synthesis of multiple compounds simultaneously and then to screen them for their activity. These techniques have evolved to the point that libraries of thousands of chemical compounds can be synthesized and screened in a single day. If these methodologies were used in the formulation of coating, the improved throughput of experiments is expected to have several important consequences. First, acceleration of the experimental process means that a series of experiments that once took six to 12 months can now take one to two weeks to arrive at the same result. This acceleration means that the time from product conception to product introduction can be shortened considerably.

<u>Correlation Between Solids Content and Hiding as it Relates to Calculation of VOC Content in Architectural Coatings, Albert Censullo, Dane Jones, Max Wills, Dept. of Chemistry and Biochemistry, California Polytechnic State University, December 2004.</u>

The researchers determined that although for a particular coating the hiding improves as the solids content increases, across different coatings, higher solids content does not necessarily equate to better hiding. In many cases, a 35 percent solids by volume water-based coating hides as well as a 60 percent solids by volume solvent-based coating. Accordingly, since the basis for using "VOC, less water and less exempts" was not supported by this study, this standard for the VOC content for house paints does not appear to be the ideal standard. The researchers developed a different standard, termed "hiding VOC", which is defined as the amount of VOCs emitted by hiding (as opposed to simply covering) one square meter with a paint. Using this measure, among the flat and nonflat paints tested, the solvent based coatings on average emitted over ten times as much VOC to hide the same area as the waterborne paints.

<u>CARB/SCAQMD Reactivity Study – Draft Report</u>

As a part of the 1999 amendments to Rule 1113 – Architectural Coatings, the AQMD Board approved a resolution, directing the staff to assess the reactivity and availability of solvents typically used in the formulation of architectural coatings. As a part of that effort, staff also included an assessment to further understand the interactions between various architectural coating emissions and mobile emission sources on particulate matter (PM) formation.

As an active member of the Reactivity Research Working Group (RRWG), a public-private partnership with a charter to conduct research on reactivity-based controls to determine whether it is feasible as an alternative compliance option, staff has coordinated their current efforts with CARB and RRWG. As part of the collaborative effort, a study was completed in 2004 using an environmental chamber at the University of California at Riverside (UCR). The study used the chamber to evaluate mechanisms for photochemical O_3 formation under low NO_x conditions (Carter 2004) and for other projects. A draft report has recently been released and the CARB and AQMD will continue to assess the draft report and will work with industry in resolving remaining concerns with the draft results.

AQMD staff will continue to monitor all reactivity-related research at the RRWG, and plans to work closely with CARB staff. However, based on the latest research and analysis, as well as the recommendations of the researched to conduct additional analysis, staff supports the continuation of a mass-based ozone control strategy, with future consideration for a reactivity-based approach. Appendix C of this report contains more detailed information regarding the research conducted relative to this study.

Alternate Means of Compliance

Averaging Compliance Option

In order to promote compliance flexibility and allow manufacturers additional time to reformulate certain compliant products of their choice, an averaging provision was added to Rule 1113. The November 8, 1996 amendments to Rule 1113, added an Averaging Compliance Option (ACO) for the Flats category. Subsequent amendments streamlined its implementation and added additional categories to provide additional compliance flexibility with the future limits. There are currently eight manufacturers that are utilizing the ACO for averaging a variety of coating categories including flats, nonflats, floor, industrial maintenance, primers, sealers, undercoaters, quick-dry primers, quick-dry sealers, quick-dry undercoaters, quick-dry enamels and rust preventative.

Three manufacturers submitted plans for the period of June 30, 2001 to July 01, 2002, all of which elected to average flat coatings. These three companies were Surface Protection Industries, Dunn-Edwards and Sherwin Williams. Staff completed audits for the first three participating manufacturers and concluded that they were fully compliant with rule requirements during that compliance period.

The second round of ACO audits is currently underway for eight participating manufacturers specific to the compliance period in 2003. The eight manufacturers' plans under review by staff include Dunn-Edwards, EVR-Gard, Frazee, ICI Dulux, Sherwin Williams, Surface Protection Industries, Tibbets Newport and Vista Paints.

The compliance period 2004 includes nine participating facilities. Staff intends to initiate auditing the 2004 ACO programs as soon as the 2003 ACO programs audits are completed. It should be noted that the eight manufacturers participating in 2003 opted to continue their plans in 2004 with slight modifications and one additional company, Rust-Oleum.

The same manufacturers that have participated in the ACO since 2003 continue to do so for the current 2005 compliance period except for Rust-Oleum. Staff has been informed by Rust-Oleum that they have reformulated their product line to meet the limits as specified in Rule 1113.

The ACO Program is available to manufacturers that desire to exceed specific coating category VOC limits by offsetting the emissions with reductions from coatings below the allowable VOC limits stated in the rule.. The extensive ongoing audit process helps to verify that the ACO program results in equivalent emission reductions and is enforceable.

<u>Sell Through Option</u>

Another compliance option available to architectural coating manufacturers allows the sale or application of a coating manufactured prior to the effective date of the corresponding standard in the Table of Standards for up to three years after the effective date of the standard. This sell-through provision applies to all coatings listed in the Table of Standards and any effective dates applicable to the specific coating. Many manufacturers continue to take advantage of this available option in order to allow them additional time to reformulate their products just prior to the effective date change in the limits. This allows the manufacturers to eliminate any potential losses in revenue due to excess stock of non-compliant coatings.

<u>Small Container Exemption</u>

The small container exemption provides VOC regulatory relief to the manufacturers provided they submit an annual report within three months of the end of each calendar year for their products that are sold in 1 quart size containers or less. If a manufacturer fails to submit their annual report, the manufacturer can no longer claim the exemption. Staff does notify the manufacturers by letter or e-mail if their annual report has not been received on time. This is done to ensure that all the manufacturers are reminded of the small container exemption and to facilitate their compliance with the rule. The number of reporting manufacturers selling coatings within the AQMDs jurisdiction under this exemption has increased over the years. Table 5 below shows the trend.

Table 5
AQMD Small Container trends, 2000-2004

	2000	2001	2002	2003	2004
No of Companies Reporting	12	12	20	24	27

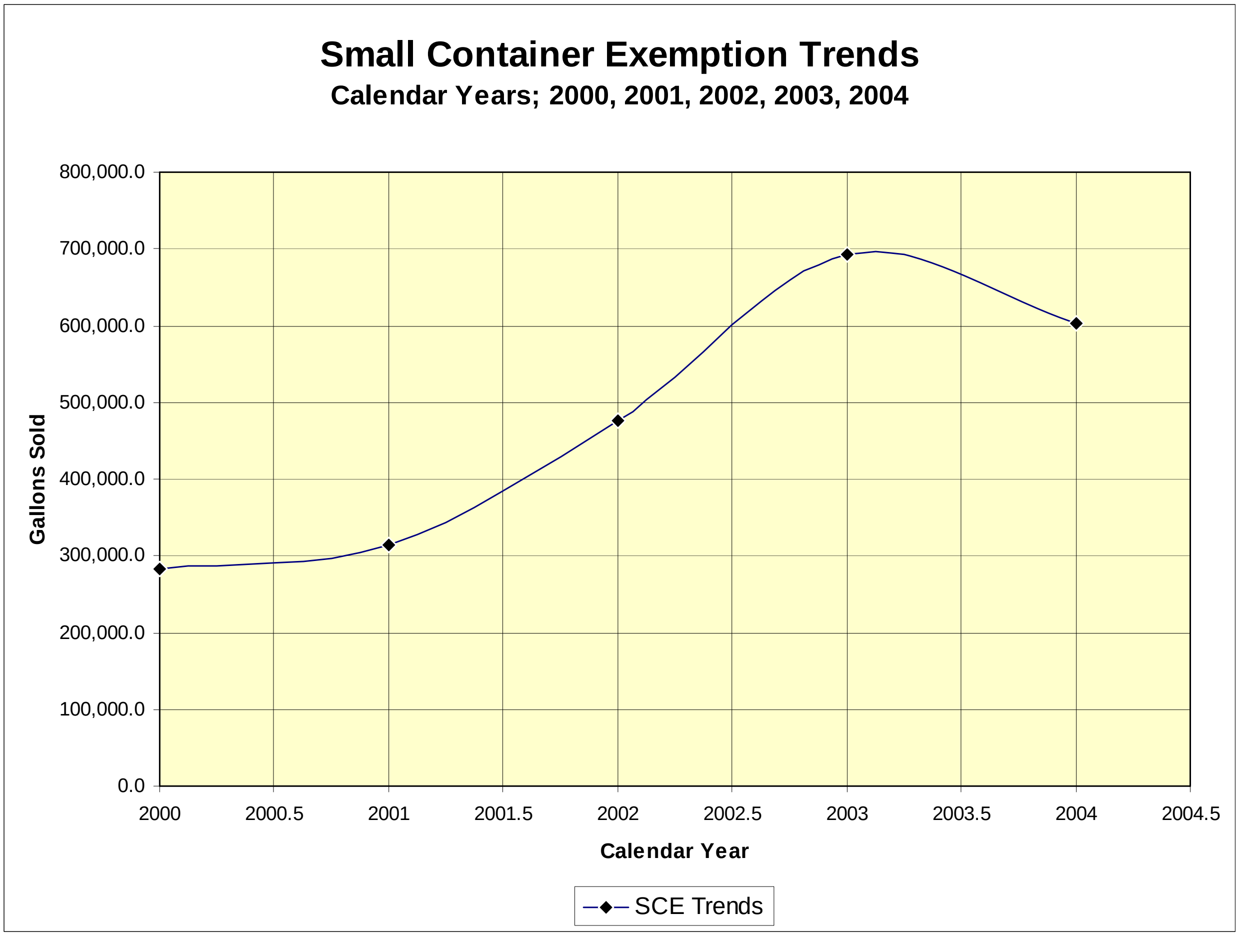
Staff has been actively tracking the statistics of the small container exemption under Rule 1113. Table 6 shown below displays the data from the year 2000 through 2004. The table also summarizes the total volume of coatings sold under the small container exemption in Rule 1113.

Table 6
AQMD Small Container Trends, 2000-2004

Coating Category	2000 (Gallons)	2001 (Gallons)	2002 (Gallons)	2003 (Gallons)	2004 (Gallons)
Faux	127.5	189.5	0.0	9,943.0	6,202.3
Flat	246.3	4,812.8	24,613.2	10,645.4	6,358.4
Floor	0.0	70.0	0.0	1,709.5	840.0
IMC	641.4	0.0	169.3	21,998.0	360.0
Lacquers	237.0	1,332.9	1,963.7	745.0	2,404.0
Mastic Coatings	0.0	0.0	0.0	35.0	0.0
Metallic Pigmented	0.0	101.0	0.0	1,487.0	153.8
Multi-color	109.0	0.0	0.0	0.0	0.0
Nonflat	13,818.6	19,748.4	9,502.9	98,752.9	36,640.5
PSU	18,864.0	13,225.2	26,196.8	25,043.3	20,118.6
QD-E				4,605.0	4,682.7
QD-PSU	1,335.0	1,651.0	327.0	4,465.0	14,826.3
Roof Coating				32,969.0	8.8
Rust Pre. (> Rule Limit)				70.0	107.0
Sanding Sealers	583.0	734.5	4,060.5	2,824.6	3,653.8
Stains	120,299.0	141,649.5	220,058.3	250,243.1	270,601.3
Traffic Coating				7,250.0	0.0
Varnishes	125,763.7	130,196.9	186,557.4	217,288.9	235,140.2
Waterproofing Sealers	196.5	48.0	1,797.5	1,477.5	78.0
WCMS				229.0	0.0
TOTALS	282,221	313,760	475,247	691,781	602,177

One can see from Table 6 that the total sales for each year increased except for year 2004. Graph 2 presents the totals shown in Table 6 in graphical format.

Graph 2
AQMD Small Container Trends, 2000-2004



Staff has analyzed the decline in the totals for the year 2004 and has found some interesting trends. The most significant changes are found in four categories including Faux Finishes, Flats, IMC and Roof Coatings, all of which show a decline in sales volume. This is shown in Table 7.

Table 7
AQMD Declining Sales Categories

Category	2003	2004	Decline in Gallons
Faux Finishes	9,943	6,202	3,741
Flats	10,645	6,358	4,287
IMC	21,998	360	21,638
Roof Coatings	32,969	9	32,960

The decline in sales would suggest that compliant products are now being offered for sale or that the products in Table 6 are no longer being sold in the AQMD jurisdiction.

Super-compliant Coatings

Architectural coating manufacturers continue to improve the coating characteristics of their products while lowering the VOCs by introducing new types of resins and other paint constituents that are extremely low in VOC or have none at all. Table 8, updated from previous annual reports to the Board, reflects a portion of super-compliant coatings currently available. Staff has given the nomenclature "Super-compliant coatings" to those coatings that exceed the current and/or future limits for the applicable coatings categories as set forth in the Table of Standards and are indicated by the manufacturer as having less than 10 g/l of VOC. These also include those coatings that meet future limits in advance of their effective date. This list is also posted to the AQMDs website showing companies that have expressed an interest in having their products included on the page.

Table 8

Super-compliant Architectural Coating Manufacturers*

Manufacturer	Type of Coatings	Interior	Exterior	Phone Number
Alistagen Corporation http://www.caliwel.com	PSU, F	YES	NO	866-280-0001 305-936-8691
American Formulators Mfg http://www.safecoatpaint.com	F, NFE, NFSG	YES	NO	619-239-0321
Anchor Paint http://www.anchorpaint.com	WPC/MS	NO	YES	918-836-4626
Behr Paints http://www.behr.com/behrx				714-545-7101
Benjamin Moore & Co http://www.benjaminmoore.com	PSU, F, NFS, NFE, NFSG	YES	NO	201-573-9600
Cloverdale Paint Inc http://www.cloverdalepaint.com	PSU, NF, IM	YES	YES	604 596 6261
Coronado Paint Co http://www.coronadopaint.com	F, NF, PSU	YES	NO	386-428-6461 x115
Diamond Vogel http://www.diamondvogel.com	F, NF, P			800-728-6435
Dunn Edwards http://www.dunneedwards.com	F, NF	YES	NO	888-337-2468
E-3 Coatings, Inc http://www.envirolast.com	S	NO	YES	530-308-2189
Frazee Industries http://www.frazeepaint.com	PSU, F, NFS, NFE, NFSG	YES	NO	858-626-3490
Fuhr International, LLC http://www.fuhrinternational.com	PSU, F, NF	YES	YES	800-558-7437 816-809-4403
ICI Paints http://www.iciduluxpaints.com Pro painters http://www.devoecoatings.com IM coatings http://www.duspec.com MSDS & PDS http://www.glidden.com Retail for homeowners http://www.ici.com Corporate	PSU, F, NFS, NFE, NFSG**	YES	YES	440-826-5519
Kryton http://www.kryton.com	WPS	YES	YES	
Miller Paint http://www.millerpaint.com	PSU, F, NFE, NFS	YES	NO	503-407-2532
Monopole Inc. http://www.monopoleinc.com	IM, WPS, WPC/MS	YES	YES	818-500-8585
Polibrid Coatings http://www.polibrid.com	F, NF, PSU	YES	YES	956-831-7818
Richards Paints http://www.richardspaint.com/	F, NFR, NFS	YES	NO	800-432-0983
Rodda Paints http://www.roddapaint.com/	PSU, F, NFE, NFS	YES	NO	503-737-6031 x6051
Sampson Coatings, Inc. http://www.sampsoncoatings.com	PSU, F, NF	YES	YES	804-359-5011

Samuel Cabot, Inc http://www.cabotstain.com	WPS	NO	YES	800-877-8246
Seal-Krete Inc. http://www.seal-krete.com	PSU, F	YES	YES	800-323-7357 x541
Sierra Performance by Rust-Oleum http://www.rustoleum.com	PSU, F, NF	YES	YES	800-553-8444
Silvertown Products http://www.rhinoguard.com	S, CWF	NO	YES	909-986-7061
Spectra-Tone Paint http://www.spectra-tone.com/	F, NFE, NFSG	YES	NO	800-272-4687
Tried & True Wood Finishes http://www.triedandtruewoodfinish.com	CWF	YES	NO	607-387-9280
VOC Free No Website	FLOOR SEALER, PSU, F, NF	YES	YES	201-457-1221
Industrial Maintenance Coatings				
Manufacturer	**Type of Coatings**	**Interior**	**Exterior**	**Phone Number**
Ameron, Intl. http://www.ameroncoatings.com/welcome.cfm	VARIOUS SYSTEMS	YES	YES	800-926-3766
Duromar http://www.duromar.com/	VARIOUS SYSTEMS	YES	YES	781-749-6992
JFB Hart Polymers http://www.jfbhartcoatings.com/	VARIOUS SYSTEMS	YES	YES	630-574-1729
Novocoat (Formerly) Superior Environmental Products, Inc http://www.novocoat.com	VARIOUS SYSTEMS	YES	YES	972-490-0566
Pacific Polymer http://www.pacpoly.com/	VARIOUS SYSTEMS	YES	YES	800-888-8340
Specialty Products Inc. http://www.specialty-products.com	VARIOUS SYSTEMS	YES	YES	253- 983-7530
United Coatings http://www.unitedcoatings.com/	VARIOUS SYSTEMS	YES	YES	800-541-4383

CWF	Clear Wood Finish
F	Flats
NF	Nonflat
NFS	Nonflat - satin
NFE	Nonflat - eggshell
NFSG	Nonflat - semi-gloss
PSU	Primers, sealers, and undercoaters
S	Stains
WPS	Waterproofing Sealer
WPCMS	Waterproofing Concrete/Masonry Sealers

** Super- compliant coatings are those coatings that exceed the current and/or future limits for the applicable coatings categories as set forth in the Table of Standards found in paragraph (c)(2)of Rule 1113 and indicate a VOC less than 10 g/l VOC.*

** Not available for exterior use

This is not an all-inclusive list of super- compliant coatings available from manufacturers/suppliers who can provide the products listed.

The SCAQMD in no way endorses any of these companies nor does it certify their ability to meet the requirements of Rule 1113 Architectural Coatings. If you want your company included in this page, please send your request to ddeboer@aqmd.gov or call David De Boer at (909) 396-2329.

Summary of Past Coating Studies

To address concerns by industry representatives and coating manufacturers that lowering the allowable VOCs in products to meet the future 2006 limits may compromise the coating characteristics such as applicability and durability, staff has contracted with industry experts and conducted several studies over the years. Staff also continues to review those completed by other agencies and the industry.

Prior reports and summaries of reports submitted to the Board regarding architectural coatings include coating technology assessments and product availability studies that indicated the availability of compliant coatings in the specific categories studied. A review of those studies supports staffs contention that super-compliant coatings meet or exceed expected characteristic performance standards compared to products that have much higher VOC content.

AVES Study

In May of 1999 the AQMD awarded a contract to AVES, an affiliate of ATC Associates Inc. to develop architectural coatings with little or no volatiles. AVES was able to develop coatings that included various stains, waterproofing sealers and clear wood finishes and presented the findings in a final report titled, "Development and Demonstration of Zero- and Low-VOC Resin Technology for Advanced Control Measure Development", issued on March 29, 2001. AQMD laboratory analysis confirmed that the new coatings formulated for the project contained less than 10 g/l of VOC s.

AQMD staffs opinion was that the coatings formulated for the study could readily be applied in typical architectural settings. In actuality, the original company, and many of its employees, along with the rights to the formulation data had been bought by a major coating manufacturer and those initial products have been further improved upon and are now commercialized throughout North America.

Public Service Agencies

The technology assessment for the Essential Public Service Agencies (EPSA) that was initiated in late 1999 at the Boards directive is progressing. The assessment was established by a committee comprised of representatives from the AQMD, Metropolitan Water AQMD of Southern California, the Department of Water Resources, Cal Trans and the Los Angeles Department of Water and Power. As reported in the "December 2003 Annual Status Report and Technology Assessments on Rule 1113", available VOC compliant industrial maintenance coating systems are undergoing performance testing, both in the laboratory and in the field that conform with the coatings industry recognized testing procedures and environments.

SCAP, a non-profit corporation organized to help ensure that regulations affecting Publicly Owned Treatment Works (POTW) are reasonable and in the publics best interest, initiated an independent study separate from the EPSA study in September 2000 to identify low-VOC coating systems suitable for wastewater treatment and conveyance facilities. Participants in this study included the Los Angeles County Sanitation AQMD, the Orange County Sanitation AQMD, the Eastern Municipal Water AQMD, Las Virgenes Municipal Water AQMD and the City of Los Angeles.

An evaluation of the performance of low-VOC atmospheric and immersion coating systems both in laboratory testing and a two-year field exposure was completed. The coating systems represented three VOC content ranges: the first group of coatings (<340 g/l to 250 g/l) complies with the current VOC limit in Rule 1113 for industrial maintenance coatings; the second group (<250 g/l to 100 g/l) represents coatings that comply with the January 1, 2004 VOC limits; and the third group of coatings (<100 g/l) meets the July 1, 2006 VOC limits.

The results of the study, completed in February 2003, indicated that compliant coating systems meeting the performance criteria for wastewater environments and 2006 limits, are currently available and perform similarly to existing coating systems.

<u>KTA-Tator</u>

In March of 2001, the AQMD awarded a contract to KTA-Tator, Inc. for the study of various coatings. The evaluation reviewed performance characteristics of 31 products in four architectural coating categories that included floor coatings, nonflat interior and exterior high gloss paints, interior and exterior primers, sealers and undercoaters and interior stains. AQMD staff concluded that the overall results substantiate current and future limits.

<u>National Technical Systems</u>

In 1998, during rule development efforts, the AQMD contracted with National Technical Systems (NTS) to obtain performance data for various coatings. The study analyzed the application and durability characteristics of 94 individual coatings and 44 coating systems. The findings of the laboratory testing portion of the study indicated that the zero- and low-VOC products showed similar and in some cases, better performance properties than the high-VOC coatings. Following the laboratory testing of the coatings, an accelerated weathering study of the coating systems including a 24-month exposure test was conducted to evaluate ambient conditions on the paint systems. At the end of the two-year outdoor test, the results continued to show that the zero and low-VOC coatings tested were similar in weathering and durability characteristics and in many cases outperformed the higher-VOC solvent borne counterparts. The same panels are still being exposed to the outdoor elements at two locations in the South Coast Air Basin. The periodic review by AQMD staff continues to show similar trends of degradation over time, further substantiating the overall good performance of the low- and zero-VOC coatings when compared to the higher VOC products in the same category.

<u>Rule 1136 Technology Assessment</u>

The technological assessment, issued in June 2003, for Rule 1136 – Wood Products Coatings indicates technology exists and is in use today in the form of many resin and solvent systems that are less than 275 g/l of VOCs for application to wood substrates. There are many companies that conduct a variety of wood finishing operations that meet the proposed 275 g/l VOC limit for clear wood finishes in Rule 1113. Those companies support the feasible use of low VOC products and staff discussions with the low-VOC coating manufacturers suggest a cross-over of use of the same products for shop- and field-finishing applications. This supports staff conclusions that the products far below 275 g/l VOC currently being utilized in the wood products manufacturing industry covered under Rule 1136 can make a transition to field applications under Rule 1113.

Current Coating Study

The requirements under Rule 1113 state that a technology assessment for certain coating categories shall be completed prior to July 1, 2005. Although not specific as to the type of assessment, the AQMD has continually sought additional funding to support laboratory testing of architectural coatings through the release of Requests for Proposals (RFP). In May of 2004, the AQMD released an RFP to solicit and qualify a consultant with technical expertise in the field of testing and analysis of recently developed and commercially available architectural and industrial maintenance coatings.

University of Missouri - Rolla Coatings Institute (UMR)

In June of 2004, a contract was awarded to UMR to conduct an evaluation of various architectural coatings as selected and approved by the TAC and AQMD staff. The testing consists three phases, each analyzing a series of coatings in one or more categories.

The first phase was completed in April 2005 and tested twelve nonflat coatings ranging from 0 to 242 g/l of VOC. There were four coatings (two high and two low) in each of three groups that were established according to high (≥70 on a 60º meter), medium (≥20 and <70 on a 60º meter) and low (<20 on a 60º meter) gloss ranges based on manufacturer supplied data. Each coating was tested for general properties as shown in Table 9.

Table 9

Tests for General Properties of all paints

Property	Standard	Number of Replicates	Substrate	Film Thickness/ Bar Type
Percent Solids	ASTM D2369-04	3	N/A	N/A
Stability	ASTM D1849-95	1	N/A	3mil/Bird bar
Stormer Viscosity	ASTM D562-01	2	N/A	N/A
Cone and Plate Viscosity	ASTM D4287-00	2	N/A	N/A
Freeze-Thaw Resistance	ASTM D2243-95	3	N/A	3 mil/Bird bar
Dry Time - Mechanical	ASTM D5895-03	2	Glass	3mil Cube Applicator
Dry Time	ASTM D1640-03	2	Glass	3mil/Bird bar
Gloss	ASTM D523-89	2	Leneta Card 1-B	3mil/Bird bar
Hide	Spectrophotometer	4	Leneta Card 1-B	3mil/Bird bar 2mil/Bird bar

Additional testing conducted specific to the nonflat coatings are shown in Table 10.

Table 10
Tests for Nonflat Paints

Property	Standard	Number of Replicates	Substrate	Film Thickness/ Bar type
Scrub Resistance	ASTM D2486-00	2	Plastic	7 mil/Dow bar
Stain Resistance	ASTM D4828 mod.	4	Plastic	7 mil/Dow bar
Blocking Resistance	ASTM D4946-89	3	Leneta Card 2-C	3 mil/Bird bar
Flow & Leveling	ASTM D4062-99	3	Leneta Card 1-B	NPCA Bar
Sag	ASTM D4400-99	3	Leneta Card 1-B	Anti-Sag meter
QUV	ASTM D4587-01	3	Aluminum	#44 Wire Wound
Surface Tension	ASTM D1331-89	3	N/A	N/A

1. Stability (Package Stability of Paint) – ASTM D1849

This test method covers the change in consistency and certain other properties that may take place when liquid paint of either the solvent-reducible or water-reducible type is stored at a temperature above 32ºF. One sample of each coating is kept at 125ºF for 30 days, followed by evaluation. Report skinning, pressure, corrosion of the container, and odor of spoilage, each quality separately designated as follows:

10	=	none	4	=	moderate
8	=	very slight	2	=	considerable
6	=	slight	0	=	complete failure

2. Stormer Viscosity – ASTM D562

This test method covers the measurement of Krebs Unit (KU) viscosity to evaluate the consistency of paints and related coatings using the Stormer-type viscometer. Consistency is the load required to produce a rotational frequency of 200 r/min for an offset paddle rotor immersed in a paint. This method is used to specify and control the consistency of paints.

3. Cone & Plate Viscosity (High-Shear Viscosity) – ASTM D4287

The viscosity value obtained by this test method gives information about the flow properties of the material under high-shear conditions similar to those encountered during application: brushing, spraying, electrostatic disk, or roll coating. This test method covers the determination of the viscosity of paints, varnishes, and related products at a rate of shear of 12,000 s^{-1}. The viscometer must provide a viscosity measurement range of either 0 to 10 poises (P) or 0 to 5 (P) at the above mentioned shear rate. The test results should be reported to the nearest 1% of the total range, that is, 0.05 for 0 to 5 P-cones, 0.1 for 0 to 10 P-cones, etc.

High-Gloss Coatings

Initial Gloss: Gloss measurements were conducted for all coatings following ASTM D53. Measured gloss ratings by this test method are obtained by comparing the specular reflectance from the specimen to that from a black standard. A highly polished, plane, black glass with a refractive index of 1.567 for the sodium D line shall be a specular gloss value 100 for each geometry test. Each 0.001 increment in refractive index produces a change of 0.27, 0.16, and 0.016 in the gloss value assigned to a polished standard for the 20o, 60 o, and 85 o geometries, respectively. One of the low-VOC coatings tested did not meet the minimal gloss criteria for high-gloss categorization, at least 70 or greater on a 60 degree meter. The remaining low-VOC product had higher specular gloss values for all gloss meter geometries measured than the two high-VOC products.

Stability: Under ASTM D1849, stability for each coating was measured and given an overall character score ranging from 0 (complete failure) to 10 (indicating the best and no change in stability). Following stability testing, gloss measurements were taken at various inclinations of the coatings that could be tested.

The results for stability indicated that for the high-gloss coatings, one high-VOC and one low-VOC coating failed. The failures were a result of the products gelling during the 30-day stability test procedure at 125^{o} F. The remaining high and low-VOC products both received an overall character score of 8, indicating a very slight change in stability.

Post Stability Gloss Measurements: The gloss measurements for the two products that passed the stability test indicate much higher gloss ratings for the low-VOC product at both 20 and 60 degree geometries. At 85 degrees, the gloss value for the low-VOC was 95.4 and for the high-VOC it was 92.9, again indicating a better value for the low-VOC product.

The initial gloss measurements, stability test and post stability gloss measurements for the low-VOC product outperformed the high-VOC product in this category.

Stormer Viscosity: The stormer viscosity test indicated one high-VOC product had a lower viscosity that the other three products. The two low and other high- VOC products had very similar viscosities.

Cone and Plate Viscosity: Under the cone and plate viscosity testing, similar consistencies were found.

Medium-Gloss Coatings

The stability test results for the four medium-gloss coatings (>20<70) indicated an overall character rating of 6, or slight change in stability for both low-VOC products. One high-VOC product also had an overall character score of 6 and the other was 7, or a very slight change in stability. Although both high-VOC products had higher initial gloss values, the gloss measurements following the stability test showed that overall, the loss of gloss for the low-VOC products was superior to that of the higher VOC products.

For the medium and low-gloss coatings, both stormer and con and plate tests showed that the low-VOC products performed similar to the higher VOC products.

Low-Gloss Coatings

The stability results for the low-gloss coatings (>5<20) show that one high-VOC product had an initial gloss measurement that should have placed it in the medium gloss category. One low-VOC product failed the stability test. The remaining low-VOC product tested as well as the other high-VOC product.

Freeze-Thaw Resistance – ASTM D2243
When water-borne coatings are shipped during cold weather, they may experience cycles of freezing and thawing. Cycles of freezing and thawing cause more damage to water-borne coatings than when the coatings are subjected to steady freezing. This test method covers a procedure for evaluating the effect of freeze-thaw cycling on the viscosity and visual film properties of water-borne coatings. The water-borne coating is put into two pint-size resin-lined cans. One can is stored at room temperature, while the other can is subjected to cycles of freezing and thawing. After cycling, the coating is examined for changes in viscosity and visual film properties. After completion, both the test and control specimens for condition are examined in the can, rating any evidence of settling, gelation, coagulation as follows:

10	=	none	4	=	moderate
8	=	very slight	2	=	considerable
6	=	slight	0	=	complete failure

A total of 8 cycles were completed for each coating in all three groups and results were reported at 1, 3, 5 and final cycles. One of the high-VOC coatings in Group 1 failed after 3 cycles and one of the low-VOC coatings failed after one cycle. The remaining high-VOC coating was rated as having very slight change after 8 cycles and the other low-VOC coating was rated as having no change at all after 8 cycles.

For the Group 2 coatings both high-VOC products completed 8 cycles with very slight to no change and one of the low-VOC products had no change, with the other failing after one cycle.

For the Group 3 coatings, the two low-VOC products failed after 1 cycle, one high-VOC failed after 3 cycles and the other failed after 5 cycles.

Each coating was rated as having very slight to no change prior to failure.

Gloss values were obtained following 1,3,5 and 8 freeze/thaw cycles where possible and compared to initial gloss values prior to the test. Overall the values were similar to the initial readings.

Mechanical Dry Time:– ASTM D5895
The drying times of a coating are significant in determining when a freshly painted room, floor or stair may be put back in use or a coated article may be handled or packaged. Slow drying may result in dirt pick-up or, on an exterior surface, moisture may cause a nonuniform appearance. This test method is used to determine the various stages of

drying or curing in the dry-film formation of organic coatings using mechanical devices for the purpose of comparing types of coatings, ingredient changes, or both.

Mechanical Recorder Straight Line Drying Time				
Stage	I	-	Set-to-Touch	Where a pear-shaped depression appears in the film when the film stops flowing over the path of the recorder's stylus and leaves a track in the film revealing the glass substrate
Stage	II	-	Tack-Free	Where the continuous track in the film ceases and the stylus starts to tear the film or leave a ragged/sharp-edged grove as it first begins to climb over the film
Stage	III	-	Dry-Hard	Where the stylus has risen out of the film and rides on the surface, leaving only a mark without disrupting the body of the film.
Stage	IV	-	Dry-Through	When the stylus no longer leaves any visible mark on the film.

For all three groups of coatings, all were tack free in under 30 minutes.

Dry-Time – ASTM 1640
Determination of the various stages and rates of film formation in the frying or curing coatings at ambient room temperature. This is significant in the development of coatings for various end used and production quality control.

Dry Time at Room Temperature		
Set-To-Touch	-	When the coating still shows a tacky condition, but none of it adheres to the finger.
Dust-Free	-	When cotton fibers can be removed by blowing lightly over the surface of the film.
Tack-Free	-	When the mechanical tack tester tips over immediately on removing a 300-g weight allowed to act for 5 s on the counter-weighted metal square base fitted with masking tape and aluminum foil.
Dry-Hard	-	When any mark left by the thumb is completely removed by the polishing operation.
Dry-Through	-	When the thumb is placed on the film, the arm of the operator is in a vertical line from the wrist to the shoulder, and the operator bears down on the film with the thumb, exerting the maximum pressure of the arm, at the same time turning the thumb through an angle of 90º in the plane of the film and there is no loosening, detachment, wrinkling, or other evidence of distortion of the film.

The set-to-touch dry times for ambient conditions under ASTM D1640 were approximately 45 minutes for the coatings in all three groups. Using a mechanical recorder the set-to-touch times were all less than 15 minutes. Based on the overall results of this aspect relative to dust pickup, the low-VOC coatings performed similar to the high-VOC counterparts and in some instances better.

Relative to tack-free dry times under ASTM D1640 all coatings were tack-free in less than one and a half hours except for one low-VOC product that dried in five hours.

The dry-hard times for the coatings in all three groups were under four hours except for one low-VOC product, Two high and one low- VOC coating in Group 1 meet the dry times for a Quick-Dry Enamel as defined in Rule 1113.

Specular Gloss – ASTM D523
Gloss is associated with the capacity of a surface to reflect more light in some directions than in others. This test method covers the measurement of the specular gloss of nonmetallic specimens for gloss meter geometries of 20º, 60º, and 85º. Measured gloss ratings by this test method are obtained by comparing the specular reflectance from the specimen to that from a black glass standard. A highly polished, plane, black glass with a refractive index of 1.567 for the sodium D line shall be assigned a specular gloss value of 100 for each geometry. Each 0.001 increment in refractive index produces a change of 0.27, 0.16, and 0.016 in the gloss value assigned to a polished standard for the 20º, 60º, and 85º geometries, respectively. For example, glass of index 1.527 would be assigned values of 89.2, 93.6, and 99.4, in order of increasing geometry.

As previously discussed, the high-gloss Group 1 coatings actually had a low-VOC product that did not meet the definition of high-gloss on a 60 degree meter. The test indicated with the exception of one low-VOC product that they all meet the definition of a non flat within their respective groups of high, medium or low-gloss.

Dry Hide – This test method is accomplished through an assessment using a Minolta CM-2002 spectrophotometer to measure lightness values over white and black areas of a Lenata chart and the CIE XYZ value for Y was recorded. The ratios of the Y values over the white section and the black section were used to calculate dry hide. – For dry hide and gloss, a three-mil Bird bar was used to apply paint to two black and white Leneta charts. Also, for hide, a two-mil Bird bar was used to apply paint to two black and white Leneta charts. Due to Beer's and Lambert's Law, hide increases as film thickness increases. Hide also increases as concentration of hiding pigments increases.

The overall results of this test procedure show that in all groups, the low-VOC coatings performed similar to the high-VOC counterparts.

Scrub Resistance – ASTM D2486, Test Method B
Paints often become soiled especially near doorways, windows, and in work and play areas. This test method determines the relative resistance of paints to erosion when repeatedly scrubbed during the life of the paint. The test paint and a reference paint are applied simultaneously perpendicular to the length of the black plastic panel. After curing, the coated panel is placed over two ½ inch by 10 mil shims that are positioned under each coating. The coatings are then scrubbed with a bristle brush and an abrasive

scrub medium until the paint film is removed in one continuous thin line across its own shim.

$$\frac{\text{Cycles for test paint}}{\text{Cycles for reference paint}} \times 100$$

if:
Result is > 100%, test paint has better scrub resistance than reference paint.

Result is < 100%, test paint has poorer scrub resistance than reference paint. UMR used a Sherwin Williams' product called Harmony as the standard.

Under the Group 1 coatings, one low-VOC product out performed the high-VOC counterparts and in Group 2 one low-VOC performed poorly with respect to the other coatings. In the Group 2 coatings one high-VOC coating outperformed the others in this group and one low and high-VOC performed equally well.

The coatings in Group 3 had the best overall scrub resistance with the high and low-VOC coatings showing similar characteristics relative to scrubability.

Stain Resistance – ASTM D4828 (modified)
Architectural paints are subjected in use to soiling by dirt or other stains. This test method provides a way to assess relative ease of soil or stain removal from a paint film using materials common to households. It evaluates the film for washability properties and changes in appearance. Four staining materials, ketchup, mustard, wine and carbon black are applied to the paint film as stripes and left for 24 hours then rinsed with de-ionized water and the film is washed for up to 100 cycles using a sponge and a non-abrasive cleaner. After rinsing and drying for one day, the panel is evaluated for any change in gloss and color between the washed and unwashed area. Color measurements are taken of the stripes with CIE XYZ values and ΔE values recorded. Gloss measurements are taken of a section of the washed area that is unstained and of the washed area that is stained so that any damage done by the washing itself is accounted for and not contributed to the staining medium. It is generally agreed by industry that a ΔE value of 1.0 is acceptable. Typically ΔE values from 0.5 to 1.0 indicate little visual change in color and values less than 0.5 have no noticeable visual change in color.

A lower differential in the ΔE value from the unwashed area to the washed area indicates less color change. The overall results of the study showed that for the Group 1 coatings all ΔE values were less than 1.0 indicating little noticeable color change for ketchup, mustard and wine. However, for the carbon stain both high-VOC coatings showed less color change.

For the Group 2 coatings a high and low-VOC had similar stain resistance characteristics for all four stains whereas the remaining coatings scored equally well for ketchup, mustard and wine; however the low-VOC showed greater color change for the carbon stain than the remaining high-VOC product.

For the Group 3 coatings, the high and low-VOC products performed similarly for ketchup and mustard stains. For the wine stain, the two low-VOC products performed somewhat better than the high-VOC. None of the coatings performed very well for the carbon stain test all having values greater than 1.8 ΔE.

Relative to gloss retention for the coatings following the application of stains and washing of the areas compared to the unstained washed areas, they appeared to perform equally well across the board for all groupings except for a few cases there was an increase in the gloss after washing the stains.

Blocking Resistance – ASTM D4946
Dried paint films are placed face-to-face and a pressure of about 1.8 psi is applied. These paint films are put into an oven for 30 minutes to make the test more stringent. After cooling, the blocked panels are peeled apart. The degree of blocking is rated subjectively for tack or seal using a series of standard descriptive terms corresponding to numerical ASTM values of 10 to 0.

Blocking Resistance Numerical Ratings	**Type of Separation**	**Performance**
10	no tack	Perfect
9	trace tack	excellent
8	Very slight tack	very good
7	very slight to slight tack	good to very good
6	slight tack	Good
5	moderate tack	Fair
4	very tacky; no seal	poor to fair
3	5 to 25% seal	Poor
2	25 to 50% seal	Poor
1	50 to 75% seal	very poor
0	75 to 100% seal	very poor

In addition to providing valuable information on the ability of a coating to resist adhesion to other surfaces, a correlation may also be drawn that poor block resistance typically translates into high dirt pick up. In general, the test results indicate that the high and low-VOC coatings performed equally well.

Flow & Leveling – ASTM D4062
The intent of this test is to simulate brush marks by applying the coating to be tested by utilizing a special test blade designed to lay down a film with parallel ridges. The leveling of the coating is rated by measuring the contrast of lightness and shadow caused by the ridges to a series of plastic leveling standards. The standard is based on a scale of 0 indicating very poor leveling to 10 indicating perfect leveling characteristics.

A review of the data relative to this test indicates that for the Group 1 coatings, the low-

VOC products scored as well as one of the high-VOC counterparts and better than the remaining high-VOC product. For the Group 2 coatings, one of the low-VOC products had very poor leveling while the other low-VOC product scored as well as one of the high-VOC products and better than the remaining one. For the Group 3 products, one low-VOC coating had very poor leveling characteristics, while the other faired as well as one of the high-VOC products and the remaining high-VOC product performed slightly better. In general, except for the two poor leveling coatings, all the products were in the middle range for flow and leveling characteristics.

Sag – ASTM D4400
A Leneta anti-sag bar is used to apply paint to a black and white Leneta chart. This bar deposits strips of paint from 3 to 12 mils thick approximately ½ inch wide. The chart is immediately lifted to a vertical position with the 12 mil thick strip at the bottom. Evaluation is based upon how much the strips flow into the strips below. The overall results of this test indicate that for the Group 1 coatings one low-VOC product had the best sag resistance and the other low-VOC product and one high-VOC product were rated in the high end of the sag resistance range. The final high-VOC product in this group was in the middle of the sag resistance range along with all the products in Group 2 and Group 3, indicating similar sag resistance characteristics.

QUV – ASTM D4587
The ability of a paint or coating to resist deterioration of its physical and optical properties caused by exposure to light, heat, and water can be very significant for many applications. This practice is intended to induce property changes associated with end-use conditions, including the effects of sunlight, moisture, and heat. Aluminum panels are subjected to UV and condensation cycles alternating every four hours. Every 200 hours total time, the panels are evaluated for gloss and color change and are totaled according to the standard used. The total time used is 1000 hours.

After 1000 hours the overall ΔE values for the Group 1 products were between 0.5 and 1.0, indicating equally acceptable performance characteristics with one low-VOC coating slightly outperforming the others. In Group 2, the coatings performed similarly except for one low-VOC product that visually showed a color change more than the others. For the Group 3 products, visually there were little visual color changes perceivable for one of the high and one of the low-VOC products. For the remaining high and low-VOC products the low-VOC product showed less color change than the other high-VOC product.

After 1000 hours the gloss values were taken and compared to initial gloss values prior to QUV exposure. The data indicates that on a 60 degree meter for the Group 1 coatings the loss of gloss for the low-VOC products was less than that for the high-VOC products. The results for the Group 2 and Group 3 products indicates that loss of gloss on a 60 degree meter from initial to final readings were less for the low-VOC products than for the high-VOC products. It should be noted that the initial readings for the low-VOC coatings in both Group 2 and Group 3 were less than those of the higher-VOC counterparts.

Surface Tension (Method A) – ASTM D1331
This test method covers the determination of the surface tension of surface-active agents. The method was written primarily to cover aqueous solutions of surface-active agents, but is also applicable to nonaqueous solutions and mixed solvent solutions. The maximum surface tension reached is reported as the length of the lamella, a useful indicator for the stabilization of foam.

The test results for surface tension characteristics indicate that the best performance was from one of the low-VOC products in Group 1.

Future Actions

Staff will continue to review and evaluate all coating categories within the Table of Standards for compliance with those limits effective in 2006 and beyond.

AQMD staff will continue work closely with the TAC to review the completed testing by UMR. In addition, staff will pursue further discussions with Cal Poly Pomona to conduct additional evaluations of coatings as selected by the TAC and staff in specific categories. Additionally, the National Paint and Coatings Association is currently in the process of releasing funding for a study that will closely follow the ongoing UMR study to determine performance and long term durability of low and ultra low VOC coatings.

At the request of Governing Board Chairman Burke, an ad hoc committee has been formed for the purpose of providing an open forum for discussion of key regulatory issues . This committee is made up of AQMD Board Members Michael Antonovich and Jan Perry, AQMD Management representatives Dr. Barry Wallerstein and Dr. Laki Tisopulos, and industry representatives Christine Stanley of Ameron and Ron Widner of Benjamin Moore. Steve Sanchez of U.S. Can Company is an industry alternate. Periodic updates will be given to the Board's Stationary Source Committee.

In addition to these technology assessments, staff will be involved in the following activities over the next year:

1. Continue holding meetings with the Ad Hoc Committee as requested;
2. Continue holding quarterly meetings and regular conference calls with the TAC;
3. Evaluation of the 2005 CARB Architectural Coatings survey for year 2004 sales;
4. Updates of low- and Super-Compliant- VOC product availability lists;
5. Review of results of studies underway by Essential Public Service Agencies on performance of industrial maintenance coatings;
6. Continuing field audits and contractor surveys of in-use applications of all coatings with future compliance dates in Rule 1113;
7. Monitor closely the technology advancements to be initiated by the actual paint and coatings manufacturers, and

8. Compliance audits of Averaging Compliance Plans

The next Status Report will be presented to the Governing Board in October of 2005.

Recommendation

AQMD staff's research of technical information from many coating manufacturers, coating studies, assessments of sales data, marketing brochures, Material Safety Data Sheets and other sources clearly shows an ever increasing number and volume of products that meet the future proposed limits.

While the UMR coating study is still ongoing, based on the results to date and on past and current technology assessments and surveys of available coatings relative to the July 2006 limits of Rule 1113, coupled with the availability of the averaging and other alternative compliance options, staff is not recommending any changes to the limits at this time. Staff will continue to work with industry and other stake holders in reviewing the technology assessment results and upon completion of the UMR study, staff intends to have a follow up report to the Board in October 2005 to reflect the study results and any adjustments to its recommendations, if warranted.

Appendices

A. Coatings Analysis

B. UMR Coatings Institute Architectural and Industrial Maintenance Coatings Assessment, Phase I Report

C. Excerpts from CARB/SCAQMD Reactivity Study – Draft Summary Report

D. Comment Letters Received and Response to Comments